Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

CSAS | SCCS

Canadian Science Advisory Secretariat | Secrétariat canadien de consultation scientifique

Research Document 2004/122 | Document de recherche 2004/122

Not to be cited without
Permission of the authors * | Ne pas citer sans
autorisation des auteurs *

Marine mammals and "wildlife rehabilitation" programs

Mammifères marins et programmes de « réhabilitation de la faune »

L.N. Measures

Fisheries and Oceans Canada
Maurice Lamontagne Institute
850 route de la mer
Mont-Joli, QC
G5H 3Z4

* This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

This document is available on the Internet at:

* La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

Ce document est disponible sur l'Internet à:

http://www.dfo-mpo.gc.ca/csas/

ISSN 1499-3848 (Printed / Imprimé)
© Her Majesty the Queen in Right of Canada, 2004
© Sa majesté la Reine, Chef du Canada, 2004

Canada

ABSTRACT

Wildlife rehabilitation involves the rescue or capture, care and treatment of abandoned, orphaned, injured or sick wild animals with the ultimate goal of returning the animal to the wild if it is healthy, able to survival and does not pose a risk to wild populations, domestic animals or public safety. Rehabilitation of marine mammals is controversial and there is no national policy nor regulation by Fisheries and Oceans Canada despite some interest and support of rehabilitation in different regions of Canada. This document reviews legislation to protect wildlife and marine mammals in Canada. There is a brief comparative overview of marine mammal legislation and protection in the United States as well as international agreements pertaining to translocation (=rehabilitation) of wildlife and disease control. A short historical review of rehabilitation of marine mammals is provided with a discussion of the pros and cons. While animal welfare is usually the predominant reason to rehabilitate wildlife there are benefits in terms of new knowledge of their diseases and ailments and veterinary therapies, identification of new threats to wild populations including species at risk and opportunities for public education in conservation. On the other hand, released rehabilitated wildlife make no significant contribution to wild populations and released animals may be disease carriers threatening wild populations especially species at risk. Introduction of novel or exotic pathogens, development of antibiotic resistance, interference in natural selection by changing gene frequencies or perpetuation of deleterious genes or creation of highly virulent pathogens are significant risks to wild populations from wildlife rehabilitation programs. Costs of rehabilitation and regulation are problems for government agencies and non-governmental groups to consider. Should marine mammal rehabilitation be permitted in Canada, recommendations with suggested regulations to reduce risks to wild populations are provided.

RÉSUMÉ

La réhabilitation d'animaux sauvages comporte la récupération ou la capture, le soin et le traitement d'un individu abandonné, orphelin, blessé ou malade dans le but ultime de le libérer dans son milieu s'il est en santé, capable de survivre et ne pose pas un risque aux populations sauvages, aux animaux domestiques ou à la sécurité publique. Non seulement la réhabilitation de mammifères marins prête-elle à controverse, mais Pêches et Océans Canada n'a en place aucun règlement ou politique pour la régir malgré l'intérêt et l'appui manifestés dans diverses régions du Canada. Le présent document est un examen de la législation visant à protéger les animaux sauvages et les mammifères marins du Canada. Il comprend un bref survol de la législation et des mesures de protection des mammifères marins aux États-Unis, ainsi que des ententes internationales relatives à la translocation (= réhabilitation) d'animaux sauvages et à la lutte contre les maladies. Un court historique de la réhabilitation des mammifères marins est présenté, ainsi qu'une discussion du pour et contre. Même si la protection des animaux sauvages est habituellement la raison principale pour laquelle ils sont réhabilités, la réhabilitation comporte d'autres avantages, comme l'acquisition de nouvelles connaissances sur les maladies et les malaises et les traitements vétérinaires fructueux, l'identification de nouvelles menaces aux populations sauvages, y compris les espèces en péril, et des opportunités de sensibilisation du public à la conservation. Par contre, les animaux sauvages réhabilités remis en liberté ne contribuent pas dans une grande mesure aux populations sauvages; ils peuvent en outre être porteurs de maladies dangereuses pour les populations sauvages, en particulier les espèces en péril. Les programmes de réhabilitation d'animaux sauvages posent aussi de graves risques pour les populations sauvages à cause de la possibilité d'introduction d'agents pathogènes nouveaux ou exotiques au sein de celles-ci, du développement d'une résistance aux antibiotiques et d'interférence dans la sélection naturelle par modification des fréquences géniques, perpétuation de gènes délétères ou création d'agents pathogènes très virulents. Les coûts de la réhabilitation et de la réglementation constituent un autre problème dont doivent tenir compte les organismes gouvernementaux et les groupes non gouvernementaux. Si la réhabilitation de mammifères marins est autorisée au Canada, les recommandations de règlements formulées permettront de réduire les risques pour les populations sauvages.

105-05971/

Introduction

Wildlife rehabilitation involves rescue or capture, care and treatment of abandoned, orphaned, injured or sick wild animals. Wildlife that has been successfully treated may or may not be released to the wild depending on the nature of their injuries and ability to resume normal activities in a manner that does not jeopardize their survival nor place the public or other animals at risk. As Hohn and Wilkinson (1996) indicate it is generally unknown whether treated and released wildlife have in fact been "rehabilitated". Unless otherwise indicated in this document, wildlife rehabilitation as practiced now generally includes "release or return" of treated animals to the wild. Depending on the situation release of rehabilitated wildlife may also involve re-introduction, translocation, re-stocking, re-inforcement or supplementation (IUCN 1995). Wildlife rehabilitation has probably been practiced for many centuries by humans on a small scale ever since the first nestling songbird fell from its nest and was picked up by a human. As an organized activity it began during the 1960s with the rise of the environmental movement. It evolved from an individual working alone in small, non-profit private organizations usually staffed by volunteers who handled small mammals and birds, often injured owls and raptors, to highly organized, relatively well funded, profit or non-profit private organizations handling a variety of wildlife, mostly terrestrial species. In many cases, veterinarians in local private clinics or veterinary colleges provided veterinary care. Animals that could not be released were usually retained for display and or educational purposes in zoological parks or aquaria.

The purpose of the present document is to provide an overview of rehabilitation as it pertains to marine mammals, to stimulate discussion within Fisheries and Oceans Canada (DFO) to develop a national policy on rehabilitation. Existing or proposed legislation involving responsible agencies and international agreements pertaining to marine mammals and control of disease in Canada, and to some extent in the United States, is provided but is not exhaustive. Marine mammal stranding and mortality events, efforts at rescue, rehabilitation and release of stranded marine mammals, advantages and disadvantages for wildlife and humans, with potential consequences and costs involved is provided. Strict regulation of marine mammal rehabilitation, if this activity is to be permitted in Canada, is recommended including addressing transboundary issues of concern to Canadian and American agencies responsible for the conservation of marine mammals especially endangered, threatened or other species at risk.

Responsible agencies and legislation

Marine mammals are highly vagile and some species undergo long distance migration for a variety of reasons (food, reproduction, environmental change). Consequently they do not respect international borders. For want of a better term species or populations of marine mammals that readily cross international borders (particularly between Canada and the United States in the present context) could be termed straddling stocks as used in management of Pacific salmon. Some marine mammal species (mostly cetaceans) are listed by the Convention on Migratory Species (CMS) (Table 1). Canada is not a signatory party to the CMS nor is the United States but the latter participates in CMS

agreements. It has been recognized that more information is required to assess stock discreteness of many marine mammal species or populations (see Dizon et al. 1997; Pfeiffer 2002). Dizon et al. (1997) indicated that determining the effectiveness of rescue and rehabilitation programs requires knowledge of stock structure. In this context it is informative to examine briefly the situation in Canada and the United States with respect to agencies and legislation protecting marine mammals and regulations governing rehabilitation of marine mammals.

Canada

In Canada regulations with respect to marine mammals fall under federal jurisdiction. Fisheries and Oceans Canada is responsible for the conservation and protection of marine resources including marine mammals (pinnipeds, cetaceans, sea otter). Polar bears are managed by the Canadian Wildlife Service and are not discussed further. Marine Mammal Regulations (MMR) fall under the Fisheries Act (amended in 1994) and stipulate that "no person shall disturb a marine mammal...." MMR are currently under revision. The Oceans Act, 1996 defines Canada's responsibility to protect and preserve the marine environment and its Oceans Management Strategy is based on the precautionary principle. Furthermore, the Minister may recommend emergency actions aimed at protecting a marine resource or habitat at risk. Certain activities which threaten a marine resource or habitat within a designated or interim marine protected area may be prohibited. The Species at Risk Act (SARA), 2003 provides special protection to wildlife designated as endangered, threatened, or of special concern including prohibition of the destruction of their habitat and SARA forbids killing, harming, harassing, capturing or taking any species so designated. The COSEWIC (Committee on the Status of Endangered Wildlife in Canada) provides advice to government on the status of wildlife species and is a legal entity under SARA. The Canada Wildlife Act, 1994 administered by the federal department of the Environment may take measures to protect any species of wildlife on federal land in danger of extinction, including in any protected marine area. The only federal legislation with respect to wildlife rehabilitation concerns issuance of permits by the Canadian Wildlife Service under the Migratory Bird Convention Act and National Policy on Oiled Birds and Oiled Species at Risk, the latter stipulating requirements for emergency rehabilitation permits. Specific knowledge, skill and facilities are required by applicants for these permits. The Health of Animals Act, 1990 is concerned with diseases and toxic substances that may affect animals or that may be transmitted by animals to persons, and with the protection of animals. The Act enables the Canadian Food Inspection Agency (CFIA) to control the use of imported pathogens and pathogens associated with reportable animal diseases. The newly formed federal National Aquatic Animal Health Program, jointly managed by DFO and CFIA, can require certification, disease diagnostics, health certification and institution of standard operational procedures (SOP) but this has not been formalized as yet

The Criminal Code of Canada will charge any one committing cruelty (unnecessary pain, suffering or injury) to an animal but there are no regulations pertaining to rescue and rehabilitation of wild animals that may find themselves in difficulty. Bill C-10B, now Bill C-22, an act proposing to amend the Criminal Code on cruelty to animals, has passed the

House of Commons and is at the Senate committee stage – amendments pertain to increasing penalties and consolidating existing offences. The Canadian Council on Animal Care (CCAC) (1980 - 1984) provides guidelines governing the use of animals including marine mammals in scientific research either in the field or laboratory and provides recommendations on husbandry, transport, captive environments, etc. New CCAC guidelines on the care and use of wildlife included a section on moving and holding wildlife with general, medical, and environmental guidelines pertaining to rehabilitation (= translocation) (CCAC 2003a). These guidelines were developed based on a Position Statement on Translocation of Living Organisms (IUCN 1987) with subsequent Guidelines for Re-Introductions (IUCN 1995) developed by The International Union for the Conservation of Nature and Natural Resources (Species Survival Commission) (IUCN-SSC) of which Canada is a member. In summary, while wildlife is afforded some protection under Canadian law there is no obligation for any agency to come to the rescue of a wild animal in difficulty, unless public safety is at risk, nor to prevent any citizen from doing so in a manner they see fit as long as laws are adhered to. In the case of marine mammal rehabilitation, a permit from the DFO authorizing a group or person to engage in such activities seems to be all that is required. No environmental impact assessment with respect to release of treated marine mammals is required, although the Minister of the Environment through the Canadian Environmental Assessment Act, in force since 1995 (amended 2003), can require that an environmental assessment (EA) be conducted before a federal authority (i.e. DFO) authorizes, issues a permit or licence or grants approval for a project that may cause significant adverse environmental effects within or outside the jurisdictions in which the project is carried out.

United States

In contrast to Canada and most other countries, the United States has very comprehensive legislation and regulations pertaining to marine mammals (see Young and Shapiro 2001 for review). In the United States the Marine Mammal Protection Act (MMPA), 1972 was created to conserve and protect marine mammals. The Endangered Species Act, 1969 (ESA) was created to protect species, subspecies or populations of animals listed as endangered, threatened or depleted and their habitat, and prohibit trade in such species. Laws and regulations pertaining to marine mammals are administered by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) depending on the species of marine mammal involved as delegated by the Secretary of the Interior and Secretary of Commerce. Both agencies have responsibilities under the MMPA and ESA and, in conjunction with the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), administer the MMPA and the Animal Welfare Act, 1966 (AWA) pertaining to marine mammals. The MMPA permits stranded marine mammals to be "taken" for protection and welfare of the animal, health and welfare of the public or nonlethal removal of nuisance animals. The AWA ensures humane care and treatment for animals used in research, public display or exhibitions and is concerned with individual animals and not conservation of species or habitat. Normally APHIS inspects facilities housing marine mammals, ensures AWA regulations are followed, investigates alleged violations and can set fines, revoke licenses or consider legal action through the USDA. While marine mammals are included under the AWA, marine

mammal rehabilitation facilities are outside its regulatory authority and no registration or license is required from the APHIS. The APHIS details specific regulations governing minimum standards for facilities housing marine mammals but these regulations do not apply to rehabilitation facilities which are deemed temporary in nature as opposed to display facilities like a zoological park. The NMFS or USFWS provides letters of agreement to various groups or organizations (usually volunteer groups of individuals, researchers or research laboratories, zoological parks or aquaria, etc.) to permit "taking" of stranded marine mammals for the purpose of rescue and rehabilitation including veterinary care. Any NMFS-regulated marine mammal (cetaceans and most pinnipeds) held for rehabilitation must be released within six months if it is eating on its own unless a veterinarian determines that release would be detrimental to the animal or to the wild population, or premature. Non-releasable animals can be retained in captivity or euthanized under permit.

The Marine Mammal Health and Stranding Response Act, 1992 (Title IV of the MMPA) requires that a program be established to collect and disseminate data on health and trends in health status of wild marine mammals correlating such data with available physical, chemical and biological environmental parameters and to co-ordinate responses to unusual mortality events. In addition to a number of activities the Marine Mammal Stranding and Response Health Program is updating procedures for rescue and rehabilitation of stranded marine mammals and developing objective release criteria for returning rehabilitated marine mammals to the wild. At present no environmental impact assessment is required. This program has increased awareness of the importance of health-related research in the conservation and protection of marine mammals in the U.S.A. (see Wilkinson, 1996; Dierauf and Gulland, 2001). In 1996 NMFS published regulations that stipulated that "no animal will be authorized for release until it is determined that the animal poses no threat to wild populations if released and that the animal is healthy and likely to survive in the wild". The NMFS is currently developing regulations for rehabilitation facilities and release guidelines for rehabilitated marine mammals (NOAA 1997).

International Agreements

The United States and Canada, are signatory parties to the Convention on International Trade in Endangered Species (CITES). Canada implements CITES through the Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act, 1996. No phocid found in Canadian waters is listed as endangered or threatened by SARA, ESA or CITES nor included under the CMS. Sympatric or potentially sympatric marine mammal species found in Canadian and U.S. waters and listed as endangered, threatened or of special concern are indicated in Table 1. A Framework for Co-operation between Canada and the United States with respect to species at risk was established between Environment Canada (Canadian Wildlife Service) and the U.S. Department of the Interior (USFWS).

The Office International des Épizooties (OIE) of which Canada is a member was created in 1924 to provide a world-wide information network of animal diseases in order to

help prevent the spread of disease as a result of international movement of animals. Recently the OIE has broadened its activities to include food safety, risk analysis, antimicrobial resistance, animal welfare and protection of the health of free-ranging mammals in order to preserve the health of domestic animals and humans and to preserve a valuable resource and maintain a natural biological equilibrium. The OIE has developed normative works such as the International Animal Health Code (2001), International Aquatic Animal Health Code (2004) which pertain to fish, molluscs and crustaceans only, Manual of Diagnostic Tests for Aquatic Animals (2003) and International Terrestrial Animal Health Code (2004). The International Council for the Exploration of the Sea (ICES) has a code of practice for the introduction and transfer of marine organisms, initially developed for marine aquaculture activities, and is concerned with introduced and exotic species including potential transfer of disease agents, and parasites that can have undesirable ecological, genetic, economic and human health impacts (ICES 2003). Canada has a similar national code applying to aquatic animals as defined in the Fisheries Act (Canadian Council of Fisheries and Aquaculture Ministers 2002). ICES (1993) reported on a workshop concerning pathogens of marine mammals and proposed actions to reduce novel disease introductions to wild populations including species at risk.

Marine mammal stranding and mortality events

A marine mammal stranding event occurs when a marine mammal comes ashore and is found in a helpless position, sick, weak or lost and unable or unwilling to return to the sea (Geraci 1978; Geraci & Lounsbury 1993). Marine mammals may also find themselves in difficulty without coming ashore such as orphaned dependent young, entanglement in fishing gear, entrapment in ice, wounded by a ship strike, covered with oil from an oil spill accident at sea or in coastal areas, or wandering far outside its normal range. Strandings generally refer to live animal strandings but a stranding may also include animals found dead on the beach as it is often unknown whether the animal came ashore alive and then died on the beach or whether it died at sea and its body was cast upon the beach (beach-cast) by wind, currents, moving ice or tides. Strandings may be single individuals or a female with dependent young. Mass strandings involve more than two individuals.

Marine mammals strand for many reasons, some of which are not fully understood (Perrin and Geraci 2002). Single strandings are usually sick or dying animals including pinnipeds, cetaceans, sirenians (manatees) or sea otters. Natural mortality affects young and old age classes predominantly and etiology may include enzootic infectious or parasitic diseases, oceanographic and environmental conditions, starvation, abandonment of young, trauma or predators. Apparent increases in moribidity and mortality may simply be a function of expanding marine mammal populations (McAlpine et al. 1999; Hammill and Stenson 2000; Lucas et al. 2003). Human-related mortality may also involve trauma (hunting, fishing activities, ship collisions), contaminants, oil spills, etc. Possible causes of mass strandings include human-related trauma, disease, pollution, oceanographic or environmental conditions, unfamiliar coastal or topographic features, natural biotoxins, predators, navigational errors due to geomagnetic disturbance, disrupted echolocation ability, following prey close to shore, and social cohesion (Geraci 1978). Species that mass

strand are usually offshore, oceanic or pelagic and highly social odontocetes such as pilot whales, sperm whales, killer or false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and common dolphins (Geraci and Lounsbury 1993). Mass strandings may include all age classes. A mass mortality or mass die-off generally refers to mortality on a large scale and is usually due to an epizootic or disease outbreak such as phocine morbillivirus which killed 18,000 seals in Europe in 1988-89 and again in 2002 (Dietz et al. 1989; Jensen et al. 2002). Mass mortalities usually occur within a restricted time period, geographic area (which could be large) and etiology may include, in addition to disease, toxic algae, barotrauma, toxic spills, or climatic events such as El Nino leading to reduced prey base and starvation (Geraci and Lounsbury, 1993; Geraci et al. 1999; Perrin and Geraci 2002). The monitoring of natural and human-related mortality of marine mammals is acknowledged as a valuable and worthwhile scientific endeavour in order to identify risks to wild populations for management and conservation purposes and to serve as indicators of ocean health (Reddy et al. 2001). Rehabilitation, however, is a separate issue to be discussed further in this document.

Rehabilitation of marine mammals

Interest in rehabilitation of marine mammals began in the late 1940s and early 1950s as a means to obtain animals for public display in zoological parks. The National Seal Sanctuary near Cornwall, England was established in 1957 and is still involved in rescue and rehabilitation of pinnipeds today. In Holland three individuals (R. Wentzel, G.J. de Haan and L. 't Hart) began rehabilitating sick adult and orphaned harbour seals on a small scale as early as 1959. This later led to creation of the Seal Research and Rehabilitation Center (SRRC) in Pieterburen, Holland in 1971 (www.zeehondencreche.nl). The SRRC handled 1475 seals during the period 1990-2001. At present there are about 100 rehabilitation centers handling marine mammals in 16 countries (Wilkinson 1996; Gulland et al. 2001; A.D.M.E. Osterhaus, pers. comm.) (Table 2). In the United States there are 47 facilities (mostly located at aquaria and zoological parks) approved for rehabilitating live stranded marine mammals (Wilkinson, 1996; Gulland et al. 2001). The largest rehabilitation center in the world is The Marine Mammal Center in Sausalito, California. This facility, in operation since 1975, has an annual budget of close to US$10million, is almost entirely privately funded by 35,000 members worldwide and has a full-time paid staff of 45 with some 800 volunteers. It rescues and treats 600 – 800 animals per year (www.marinemammalcenter.org).

Rehabilitation of wildlife can increase our knowledge of diseases and ailments of wildlife and this knowledge can also be of benefit to domestic animals or humans. Certainly there have been tremendous gains in veterinary medicine with respect to scientific knowledge and therapy of stranded marine mammals (see St. Aubin et al. 1996; Dierauf and Gulland 2001). Rehabilitation is rarely of value from a conservation perspective and is generally more concerned with an individual animal's welfare (Wilkinson and Worthy 1999, Gulland 1999, Gulland et al. 2001). Rehabilitated animals make no significant contribution to large, healthy wild populations. However, training of personnel in rehabilitation of species not at risk can be useful in maintaining expertise in rehabilitation of species at risk or in rescue of marine mammals in difficulty due to ship

collision, oil spills, fishery interactions, ice entrapments, etc. Rehabilitation of endangered species may be the only way to replenish depleted populations or create new sub-populations in more secure habitats. Release of rehabilitated animals offers opportunities to attach radio-transmitters to follow movements and behaviours of animals for which such data is lacking and difficult to obtain, although some question whether these animals are behaving normally. Stranded animals undergoing rehabilitation can provide information on the health status of wild populations, although data is usually biased by highly skewed age and sex distributions commonly seen in stranded animals (i.e. it is usually the sick, young and old that strand) (Gulland 1999). McCallum and Dobson (1995) noted increasing research interest in the effect of diseases and parasites at the population level rather than at an individual level. New diseases, pathogens and toxins and associated clinical signs helpful in diagnoses, have been observed in animals undergoing rehabilitation. Many of these new diseases and pathogens would be difficult to identify in beach-cast carcasses unless they were very fresh. New environmental threats to oceans and marine resources such as biotoxins, chemical contaminants and pathogen pollution have been documented in marine mammals undergoing rehabilitation (see Reddy et al. 2001), although fresh beach-cast carcasses have been equally valuable in elucidating these new threats. In fact, fresh carcasses can be of greater value than some live animals destined for release by providing some samples that cannot obviously be collected from a living animal. Rehabilitation offers many opportunities to educate the public on threats to marine mammals and marine environments and promote conservation. Certainly public interest and concern is heightened during stranding events, particularly when cetaceans are involved.

In the late 1960s and early 1970s public interest in marine mammals, especially during stranding events and controversies surrounding commercial whaling, increased worldwide. Kellert (1991) examined Canadian attitudes and views on marine mammals and found that, like most Americans, Canadians are concerned about marine mammals, especially endangered species, and their environment. However, Canadians differ somewhat from Americans in supporting harvesting of some marine mammals for profit and subsistence or to protect fishery activities (see Lavigne et al. 1999 for extensive analysis of North American attitudes). Canadian attitudes with respect to rehabilitation of marine mammals were not examined but may be similar to those of Americans who support extensive efforts to rescue, rehabilitate and release marine mammals that strand (Geraci and Lounsbury 1993). It is important to note that compared to pinnipeds, cetaceans seem to garner more concern and attention from the public and media. Kellert (1991) also reported that urban people showed greater concern for marine mammals than rural people.

In eastern Canada there were two groups that had been issued permits from DFO to rescue or rehabilitate marine mammals - the Maritime Animal Response Society (MARS), affiliated with Dalhousie University in Halifax, and the Eastern Shore Wildlife Rehabilitation and Rescue Center in Musquodoboit Harbour (about 80 km east of Halifax) – permits were not issued in 2003 nor 2004 (C. MacDonald, DFO, Halifax). The center in Musquodoboit handled terrestrial as well as marine wildlife. Until recently, a small number of animals, mostly seals, were rehabilitated annually at the Atlantic Veterinary College (since about 1995) but a permit was not re-issued (G. Desprès, DFO, Moncton). A recent request to start a rehabilitation center in New Brunswick was denied. The Quebec

Aquarium in Quebec City, the Biodome in Montreal and a wildlife rehabilitation group in Montreal (Urban Animal Advocates) were involved in some seal and orphaned beluga rehabilitation in the past. From 1994 to 2001 16 seals, mostly hooded seal pups but also a few harbour and harp seal pups, were handled for rehabilitation purposes at the Quebec Aquarium and 6 were released (10 others died) (SPSNQ 2005). Under scientific advice, this rehabilitation and release ceased in order to protect wild populations especially the St. Lawrence beluga (D. Tremblay, DFO, Québec). In western Canada there are two groups that have been issued permits from DFO to rescue or rehabilitate marine mammals - the Island Wildlife Natural Care Center on Saltspring Island and the Vancouver Aquarium. The Saltspring Island center has been in operation for about 8 years and handles up to 85 harbour seal pups per year in addition to hundreds of terrestrial wildlife (www.sealrescue.org). The Vancouver Aquarium has been operating a marine mammal rescue program since 1960 and a new facility was completed in 2004. From 40 to 100 animals, mostly Pacific harbour seal pups, are handled per year (www.vanaqua.org). One rehabilitation center in British Columbia had its permit withdrawn by DFO (M. Joyce, DFO, Vancouver). Many rehabilitation centers particularly in North America handle multiple wildlife species (terrestrial and aquatic) while others only handle aquatic species including pinnipeds, cetaceans, manatees, marine turtles, marine birds and some fish. Relatively few rehabilitation centers handle marine mammals exclusively. Marine mammals commonly rehabilitated include pinnipeds, sea otters, manatees and small odontocetes.

Numerous studies have documented stranding events and efforts at rescue and rehabilitation. Up to 90% of stranded marine mammals, the majority being pinnipeds, are found dead (Gulland et al. 2001). Of those animals that are alive efforts to return them to sea immediately, especially cetaceans, have met with mixed success (Geraci and St. Aubin 1979; Odell et al. 1980; Reynolds and Odell 1991; Perrin and Geraci 2002). Single stranded pinnipeds are generally sick and cannot be returned to sea. Some marine mammals restrand immediately post-release in the same location or elsewhere days or even weeks later. More inshore species of odontocetes are found dead than offshore species. Large baleen whales which rarely strand alive, die quickly due to cardiorespiraory collapse and shock unless they are very young calves. One neonatal baleen whale was successfully rescued, rehabilitated and released but little information on its survival post-release was obtained (Stewart et al. 2001). Large odontocetes, such as sperm whales, are difficult to return to sea due to their size and may take days to die on the beach (Evans et al. 2002; L. Measures unpub. data). Small odontocetes and pinnipeds (mostly young-of-the-year and juveniles) are easier to rescue (return to sea) or transport and rehabilitate (Early and McKenzie 1991; Wiley et al. 2001; Lander et al. 2002; Nawojchik et al. 2003). Some species pose technical challenges and success in rehabilitation has been elusive (Manire et al. 2004). Successful rescue and rehabilitation depends on rapid response, proximity of adequate facilities, available resources (funding and personnel) and the expertise of the rehabilitation team.

In the 1970s the number of live stranded animals rescued, treated and released was low. Many were retained to stock display facilities such as aquaria and zoological parks or were used in research as suggested by Ridgway and Prescott (1979). Hohn and Wilkinson

(1996) documented a decrease in the number of pinnipeds retained and an increase in the number of pinnipeds treated and released from 1973 to 1991, attributed to requirements by the MMPA, improved veterinary knowledge, better facilities, and recent events involving large numbers of strandings (i.e. El Nino, epizootics, toxins) and expanding wild populations or range extensions. Equivalent numbers for cetaceans are low due to the fact that few survive on the beach or survive long enough to be treated and released. For example, Seagars et al. (1986) reported 68% of 1406 live stranded pinnipeds admitted to rehabilitation centers in California in 1983 (an El Nino winter) died or were euthanized and of the surviving 444, 24% were retained in captivity and 76% were released. The number of cetaceans treated at rehabilitation centers remained constant from 1973 to 1990 (mean of 2 per year) and very few survived to be released (Hohn and Wilkinson 1996). Recurrent disease or congenital defects often kill animals despite good veterinary care in captivity (Dierauf et al. 1986; Seagars and Jozwiak 1991; Gage et al. 1993; Walsh et al. 2001). Lander et al. (2002) reported success rates (number released/number admitted x 100) for harbour seal pups of 39, 25, 15, 56, and 63% for the years 1995, 1996, 1998, 1999, and 2000, respectively. At certain times of the year in most regions with harbour seal populations, unweaned pups dominate the number of marine mammals reported "stranded" or picked up by the public or by stranding network personnel due to human disturbance. These are usually healthy pups temporarily left on beaches, rocks or reefs by their mothers while she forages nearby. Many well-meaning but uninformed members of the public believe these pups are "abandoned" and in need of rescue (Scordino 1991; Seagars and Jozwiak 1991; Lander et al. 2002; L. Measures, unpub. data). A policy of waiting 24 – 48 hours before responding and public education has been useful in reducing these false "strandings" and needless rehabilitation efforts. Protection of known pupping areas to reduce human disturbance is pro-active. Public education by the scientific community would alleviate misguided public and media attention which can lead to misplaced use of limited resources (Domning 1999).

There is considerable controversy concerning rehabilitation of marine mammals (see Geraci and St. Aubin 1979; Seagars et al. 1986; Seagars and Jozwiak 1991; Nitta 1991; Le Boeuf 1996; St. Aubin et al. 1996; Wilkinson 1996; Wilkinson & Worthy 1999; Gulland et al. 2001; Malakoff 2001; Perrin and Geraci 2002). Does rehabilitation work? Do treated and released animals survive, resume normal activities, reproduce? Do treated and released animals which appear clinically normal transmit disease, i.e. are they disease carriers or contribute to changing disease dynamics in wild populations? Is their immune system or normal bacterial flora adequate in responding to the assault and competition from other pathogens to which they will be exposed at release? Do treated and released animals transmit their "bad" genes to future generations? Are humans interfering with natural selection, driving evolutionary changes in the host and their parasites or pathogens i.e. increased or decreased transmission rates and virulence? Most of these questions remain unanswered.

Recent work has endeavoured to document survival post-rescue, and after treatment of marine mammals in rehabilitation facilities with subsequent release using observation, flipper tags, colour markings, head tags, photo-identification and satellite-linked time-depth recorders (Seagars 1988; Harvey 1991; Scordino 1991; Early and McKenzie 1991;

Gales and Waples 1993; Mate et al. 1994; Davis et al. 1996; Reijnders et al. 1996; Wells et al. 1998, 1999; Lander et al. 2000; Barnett and Westcott 2001; Scott et al. 2001; Wiley et al. 2001; Stewart et al. 2001; Lander et al. 2002; Vincent et al. 2002; Manire et al. 2004). Data indicates that some animals survive for short periods of time (days, weeks or months), very few have been observed as long as 2 years post-release (Seagars 1988). Long-term survival is difficult to demonstrate due to intentional or non-intentional tag loss, particularly on cetaceans (Gales and Waples 1993; Lander et al. 2000; Scott et al. 2001; Stewart et al. 2001; Manire et al. 2004). Juvenile pinnipeds appear to behave normally and disperse over wide areas, joining local colonies within a few weeks (Vincent et al. 2002). Some animals re-strand, sometimes several times, and some are found dead in poor body condition. Some are shot perhaps due to human habituation or are found dead in fishing gear (G. Early, pers. comm; L. Measures, unpub. data). The best chance for survival post-release appears to be releasing juvenile pinnipeds held for rehabilitation no longer than one year, preferably less. Mass at release seems to influence length of survival (Harvey 1991) as does mass at birth and weaning (Bowen et al. 1994; Coltman et al. 1998). Some rehabilitated, released and tagged arctic phocids have been documented to travel considerable distances, in other cases some are found dead within months of release with no obvious cause of death other than poor body condition (Greg Early, Keith Matassa, pers. comm.). In a 3-year study of rehabilitated harbour seal pups, Lander et al. (2002) observed a decrease in survival in rehabilitated harbour seal pups compared to wild pups monitored 5 mo post-release using radio-tracking. The relationship between genetics, disease and survival (see Scott 1988) has been documented in dolphins and seals (Acevedo-Whitehouse et al. 2003; Valsecchi et al. 2004; Bean et al. 2004). For example, Acevedo-Whitehouse et al. (2003) showed that rescued California sea lions that were more inbred compared to controls took longer to recover while in rehabilitation involving added costs, had greater susceptibility to infectious disease (bacteria, helminths), harboured a wider range of helminth infections and they concluded that the most inbred individuals could act as effective reservoirs of infectious agents post-release. No published study has demonstrated that a rehabilitated and released marine mammal has survived to reproduce.

Risk of spreading disease, enzootic or exotic, from rescued or rehabilitated marine mammals to wild free-ranging populations or even to valuable animals in zoological collections has been recognized as a serious threat to rehabilitation programs and endangered species (Miller 1996; Montali and Bush 1996; Hohn and Wilkinson 1996; St. Aubin et al. 1996; Wilkinson and Worthy 1999; Wiley et al. 2001; Malakoff 2001; Walsh et al. 2001; Gaydos et al. 2004). It has been documented that rescued animals can bring diseases into rehabilitation facilities and that these diseases can circulate among other animals undergoing rehabilitation, animals that are often naïve and immunocompromised (Table 3). Nosocomial infections (diseases acquired in clinical settings either from other patients or from care-givers acting as cultural vectors) are recognized as serious problems in human hospitals or veterinary clinics by the medical and veterinary professions (Haley et al. 1985; Ewald 1994; Erwin et al. 2004; Cherry et al. 2004; van Duijkeren et al. 2004). Unlike humans or our domestic animals, wildlife once released to the wild cannot return for clinical follow-up or further treatment should things go wrong. Terrestrial diseases can be transmitted to marine mammals within multiple species rehabilitation centers or from domestic or wild terrestrial species gaining entry to rehabilitation centers or amongst wild

marine mammals in coastal environments in close proximity to human habitation (Table 3) but the former (clinical settings) is likely underreported. Mos et al. (2003) warned that interspecies transmission of pathogens such as canine distemper virus within multiple species rehabilitation centers could be catastrophic for local susceptible aquatic wildlife populations. Human diseases can also be transmitted to marine mammals (Osterhaus et al. 2000; Ohishi et al. 2002, 2004). Such transfer was called zooanthroponosis in contrast to diseases of animals transmitted to humans (anthropozoonosis) – now simplified to zoonosis in both cases (Hubálek 2003). Montali and Bush (1996) indicated that infectious disease and animals with genetically-based defects should be carefully excluded from re-introduction programs involving threatened or endangered species. Some wild marine mammal populations, are at particular risk from exotic or novel pathogens as they may be immunocompromised by certain chemical contaminants (immunotoxicants) in their tissues that can affect their immune system (Ross 2002). A variety of emerging infectious diseases in wildlife including novel diseases in marine mammals due to human activites are considered serious threats to diversity, human health and conservation of species at risk (Woodford and Rossiter 1993; Daszak et al. 2001; Alexander et al. 2002).

Reeves and Reijnders (2002) recommended that rescue, rehabilitation and release should be reserved mainly for endangered species or populations but endangered populations or small, isolated populations with low genetic diversity are particularly at risk from disease from translocated or released rehabilitated animals (O'Brien and Evermann 1988; Spalding and Forrester 1993; McCallum and Dobson 1995; Cunningham 1996; Cleaveland et al. 2001). Disease has been recognized as one of many castastrophic or stochastic factors that can drive small populations to extinction (see Gulland 1997; Cleaveland et al. 2001), particularly from infectious diseases maintained in reservoir species or in hosts with impaired immune systems (Laffety and Gerber 2002). To date there are no documented cases of rehabilitated and released marine mammals transmitting disease to wild populations although this would be difficult to demonstrate without extensive post-release monitoring and good baseline data (Scott 1988; Griffith et al. 1993; Spalding and Forrester 1993). The recent occurrence of Influenza A/Bangkok/1/79 (H3N2) and Influenza B (the latter a pathogen of humans) in wild European seals may be cases in point but further research is required. Nevertheless there are many documented cases of translocated wildlife including terrestrial mammals, reptiles, shellfish and fish that have exacerbated the spread of disease (Woodford and Rossiter 1993; Arthur 1995; Cleaveland et al. 2001). Wildlife can acquire diseases from humans or their domestic animals (O'Brien and Evermann 1988; Lafferty and Gerber 2002; Riley et al. 2004) and this is becoming an increasing problem in the marine environment (Harvell et al. 1999; Daszak et al. 2000a, 2000b; Brownell et al. 2000) (Table 3). For example, canine distemper virus (=morbillivirus) from domestic dogs or terrestrial carnivores infected Baikal and Caspian seals, respectively, leading to population declines (Mamaev et al. 1995, Forysth et al. 1998). Osterhaus (2001) outlined the problems of diseases crossing species barriers due to social, technological and ecologic changes. Many new and emerging diseases of marine mammals have been discovered within the last 15 years (i.e. phocine morbillivirus, cetacean morbillivirus, *Brucella cetaceae* and *B. pinnipediae*, Influenza A and B, West Nile Virus, Alphavirus, phocine herpesvirus-1 and -2, *Mycobacterium* sp., *Sarcocystis neurona*, *Toxoplasma gondii*, *Giardia duodenalis*, *Cryptosporidium parvum*, etc.) and

likely more remain to be discovered. Human intervention in marine mammal strandings, while well-intentioned, could be very risky to wild populations already at risk from immunotoxicants genotoxicants, and new and emerging diseases (Miller et al. 2001) and such interventions can have unforeseen consequences especially for endangered or threatened species (Scott 1988; Cunningham 1996; Larson 1998; Brownell et al. 2000; Daszak et al. 2000a, 2000b, 2001; Lafferty and Gerber 2002). The responsible ministries of three European governments (Denmark, Germany, Holland) advocated reduced rehabilitation and release of harbour seals once the population in the North Sea had recovered from the 1988-89 phocine distemper viral epizootic (Reijnders 1996 in Reeves and Reijnders 2002).

Potentially the most dangerous threat posed by rehabilitation and release of marine mammals is from the infectious agents they bring into rehabilitation centers or acquire while undergoing treatment. Not all infectious agents cause disease and detection can be problematic in wild populations or clinical settings (Scott 1988; Spalding and Forrester 1993), especially in those animals showing no clinical disease yet could be important carriers of infection. Few studies have attempted to document the normal bacterial or viral flora of free-ranging marine mammals but stranded sick marine mammals often have normal and opportunitistic infections (Thornton et al. 1998). Pathogens, particularly viruses, bacteria and some protozoans, replicate much quicker than their hosts but are subject to selective forces which can drive microbial adaptation and evolution leading to increased or decreased transmission rate, virulence and pathogenicity through changes in gene frequency (Ewald 1980, 1983, 1994; Su et al. 2003). Infectious agents can undergo mutation (antigenic shift), genetic drift, genetic shift, latency, reactivation, genetic recombination, genetic reassortment, conjugation, transformation and transduction (Ewald 1994; Kruse et al. 2004). Such changes can occur when infectious agents encounter new hosts or debilitated hosts under nutritional, environmental or other stresses, clinical treatments such as antibiotics, other genetically similar agents or new environments with multiple species held in high density (Scott 1988; Ewald 1980, 1994; Woodford and Rossiter 1993; McCallum and Dobson 1995). These microbial changes or adaptations can influence the epizootiology of diseases, including zoonotic diseases (Kruse et al. 2004), and drive host selection (see Acevedo-Whitehouse et al. 2003; Valsecchi et al. 2004; Bean et al. 2004). Diseases and parasites can have significant effects on hosts including their immune system, genetic diversity, behaviour, reproductive success, susceptibility to other diseases or predators, population demography and other biological and ecological determinants of competitive fitness, and survival. The discovery of an unusual genotype of *Toxoplasma gondii* and unexpected gene frequencies of this parasitic protozoan in the threatened California sea otter (Miller et al. 2004) may be the first evidence of selective forces driving microbial adaptation in the marine environment but further data is required. The potential for genetic reassortment of influenza viruses in marine mammals leading to increased virulence in marine mammals or humans is troublesome (Webster et al. 1981; Osterhaus et al. 2000; Ohishi et al. 2002, 2004).

In addition to disease, use of antibiotics in the treatment of marine mammals undergoing rehabilitation may create antibiotic-resistant pathogens. For example, some hospitals, veterinary clinics and rehabilitation centers do not test for the presence of

antibiotic resistant bacteria prior to or after administering antibiotics usually to expedite treatment. Antibiotic resistant bacteria have been found in marine mammals (Johnson et al. 1998); however, contamination of the marine environment from human sewage and agricultural runoff may be important point sources of antibiotic residues (Ash et al. 2002; Wise and Soulsbury 2002). Seal meat containing residues of various drugs used in treating marine mammals could be consumed by native peoples or other hunters when rehabilitated and released arctic phocids are shot for subsistence (Greg Early, pers. comm.). This may compromise Canada's domestic seal meat market and potential to develop international markets as well as pose a risk to human health.

Rescuing, treating and releasing marine mammals is costly, up to US $50,000 for a seal and up to US $1 million for a whale (Malakoff 2001). In Canada costs to rescue and rehabilitate Pacific harbour seal pups are about CAN $1,000 each animal (CBC 2005). Rehabilitation facilities are costly and existing facilities at zoological parks and aquaria in Canada can handle a few individuals to a couple of dozen animals at a time, usually pinnipeds. Asper et al. (1988 cited in Odell 1991) estimated that aquaria and zoological parks in the U.S. engaging in marine mammal stranding programs respond to about 850 live strandings at an estimated cost of US$1 million per year. Costs are likely much higher at present. The Marine Mammal Rescue Assistance Act of 2000 amended the MMPA to establish the John H. Prescott Marine Mammal Rescue Assistance Grant Program, administered by the NMFS, providing funds (US $7.4 million in 2004) to authorized rehabilitation facilities and eligible stranding network participants in order to rescue and rehabilitate stranded marine mammals, collect data from living or dead stranded marine mammals, upgrade rehabilitation facilities and assist with operational and personnel costs (US $3.74 million is proposed for fiscal year 2005). Rehabilitation activities in the U.S. requires increasing resources, both in personnel and funding, from the NMFS to meet its mandate and responsibilities under the MMPA.

Recommendations

Given that different regions of Canada vary in their interest or support of rehabilitation and that such activities including transboundary issues may be putting wild populations at risk it is recommended that a national policy on rehabilitation of marine mammals be established by the DFO based on the precautionary principle. Until it can be conclusively demonstrated that such activities do not place wild populations or endangered species at risk, it is prudent that rehabilitation should be prohibited in Canada or strictly regulated.

Regulation may include but not be limited to certification of rehabilitation facilities with regular inspection, minimum standards of veterinary care, training and standards for qualified personnel, rigorous standard operational procedures, good clinical practices, biocontainment, hygienic practices, quarantine requirements and strict procedures on disease control, use of antibiotics and other drugs, euthanasia and sanitary carcass disposal, obligatory necropsy to determine cause of death and collect samples for research and monitoring and development of release criteria using risk analysis and environmental impact assessment. Thorough analysis of veterinary history, clinical examination including

evaluation of carrier status and immune competence should be evaluated in risk analysis to determine releaseability. Post-release monitoring is also required to document the fate of released individuals. Knowledge of the normal pathogen fauna of species under rehabilitation (i.e. harbour seals) as well as potential predators (i.e. killer whales) in a region where treated animals are to be released is essential in assessing the chances of success of a release as well as assessing the risk to wild populations of transmitting disease or novel pathogens. Rehabilitation of marine mammals should not be permitted in wildlife rehabilitation centers also treating terrestrial wildlife species or domestic animals. Rehabilitation centers should have in-house animal care committees operating within the guidelines of the CCAC. Additional guidelines developed by the OIE, IUCN and CCAC are useful and should be followed for the welfare of released animals, control of disease, behavioural and genetic aberrations, biocontainment standards for laboratories and maintenance of healthy wild populations and the ecological integrity of the areas they inhabit. Costs incurred by meeting regulatory requirements should be borne by each rehabilitation facility and failure to comply with regulations would result in loss of certification and withdrawal of permits authorizing rehabilitation of marine mammals in that facility. The purpose of the present document is not to include all possible regulations, however. Appendix 1 outlines in point form some of the above suggested requirements relative to reducing risks identified in this document.

Public education on normal behaviour of marine mammals, especially harbour seals pups during the lactation and weaning period, would be helpful in reducing needless "rescue" and death of orphaned animals and promote conservation. This should be a core requirement of any rehabilitation facility and the DFO can provide information to facilitate public education when required. The above concerns about Canadian marine mammals at risk such as the killer whale, the St. Lawrence beluga, blue whale, harbour porpoise, etc. threatened by diseases potentially carried by straddling stocks of marine mammals rehabilitated in the U.S. should be formally conveyed to the U.S. government and policies developed for straddling stocks.

Literature Cited

Acevedo-Whitehouse, K., F. Gulland, D. Greig and W. Amos. 2003. Disease susceptibility in California sea lions. Nature 422: 35.

Agriculture and Agri-Food Canada (AAFC) 1996. Containment standards for veterinary facilities. Government of Canada. Ottawa, Ontario.

Alexander, K.A., E. Pleydell, M.C. Williams, E.P. Lane, J.F.C. Nyange and A.L. Michel. 2002. *Mycobacterium tuberculosis*: an emerging disease of free-ranging wildlife. Emerging Infectious Diseases 8: 598 – 601.

Arthur, J.R. 1995. Efforts to prevent the international spread of diseases of aquatic organisms, with emphasis on the Southeast Asian region. pp. 9 – 25. In Diseases in Asian Aquaculture II. Edited by M. Shariff, J.R. Arthur and R.P. Subasinghe. Asian Fisheries Society, Manila.

Ash, R.J., B. Mauck and M. Morgan. 2002. Antibiotic resistance gram-negative bacteria in rivers, United States. Emerging Infectious Diseases 8: 713 – 716.

Aschfalk, A., L. Folkow, H. Rud and N. Denzin. 2002. Apparent seroprevalence of *Salmonella* spp. in harp seals in the Greenland Sea as determined by enzyme-linked immunosorbent assay. Veterinary Research Communications 26: 523 – 530.

Baker, J.R., A. Hall, L. Hiby, R. Munro, I. Robinson and H.M. Ross. 1995. Isolation of salmonellae from seals from UK waters. The Veterinary Record 136: 471 – 472.

Barnett, J. and S. Westcott. 2001. Distribution, demographics and survivorship of grey seal pups (*Halichoerus grypus*) rehabilitated in southwest England. Mammalia 65: 349 – 361.

Bean, K., W. Amos, P.P. Pomeroy, S.D. Twiss, T.N. Coulson and I.L. Boyd. 2004. Patterns of parental relatedness and pup survival in the grey seal (*Halichoerus grypus*). Molecular Ecology 13: 2365 – 2370.

Bengston, J.L., P. Boveng, U. Franzen, P. Have, M.-P. Heide-Jorgensen, T.J. Harkonen. 1991. Antibodies to canine distemper virus in Antarctic seals. Marine Mammal Science 7: 85 – 87.

Bowen, W.D., O.T. Oftedal, D.J. Boness and S.J. Iverson. 1994. The effect of maternal age and other factors on birth mass in the harbour seal. Canadian Journal of Zoology 72: 8 – 14.

Brownell, R.L., B.E. Curry, W. Van Bonn, S.H. Ridgway. 2000. Conservation conundrum. Science 288: 2319.

Canadian Broadcasting Corp (CBC). 2005. Controversy over private wildlife rescue centers. The National. Jan. 14, 2005. #6326-18. Transcriptions Verbatim Inc.

Canadian Council on Animal Care (CCAC). 1980 - 1984. Guide to the care and use of experimental animals. 2 vols. Ottawa, Ontario.

Canadian Council on Animal Care (CCAC). 2003a. CCAC guidelines on the care and use of wildlife. Ottawa, Ontario.

Canadian Council on Animal Care (CCAC). 2003b. CCAC guidelines on: laboratory animal facilities – characteristics, design and development. Ottawa, Ontario.

Canadian Council of Fisheries and Aquaculture Ministers. 2002. National Code on introductions and transfers of aquatic organisms. 54 p.

Cherry, B., A. Burns, G.S. Johnson, H. Pfeiffer, N. Dumas, D. Barrett, P.L. McDonough and M. Eidson. 2004. *Salmonella typhimurium* outbreak associated with veterinary clinic. Emerging Infectious Diseases 10: 2249 – 2251.

Cleaveland, S., G.R. Hess, A. P. Dobson, M.K. Laurenson, H.I. McCallum, M.G. Roberts and R. Woodroff. 2001. The role of pathogens in biological conservation. pp. 139 - 150. In The ecology of wildlife diseases. Edited by P.J. Hudson, A. Rizzoli, B.T. Grenfell, H. Heesterbeek and A.P. Dobson. Oxford University Press, Oxford.

Coltman, D.W., W.D. Bown and J.M. Wright. 1998. Birth weight and neonatal survival of harbour seal pups are positively correlated with genetic variation measured by microsatellites. Proceedings of the Royal Society of London B 265: 803 – 809.

Cousins, D.V., S.N. Williams, R. Reuter, D. Forshaw, B. Chadwick, D. Coughran, P. Collins and N. Gales. 1993. Tuberculosis in wild seals and characterization of the seal bacillus. Australian Veterinary Journal 70: 92 – 97.

Cunningham, A.A. 1996. Disease risks of wildlife translocations. Conservation Biology 10: 349 – 353.

Daszak, P., A.A. Cunningham and A.D. Hyatt. 2000a. Emerging infectious diseases of wildlife – threats to biodiversity and human health. Science 287: 443 – 449.

Daszak, P., A.A. Cunningham and A.E. Hyatt. 2000b. Conservation conundrum. response. Science 288: 2320.

Daszak, P., A.A. Cunningham and A.D. Hyatt. 2001. Anthropogenic environmental change and the emergence of infectious diseases in wildlife. Acta Tropica 78: 103 – 116.

Davis, R.W., G.A.J. Worthy, B. Würsig, S.K. Lynn and F.I. Townsend. 1996. Diving behavior and at-sea movements of an Atlantic spotted dolphin in the Gulf of Mexico. Marine Mammal Science 12: 569 – 581.

Deng, M., R.P. Peterson and D.O. Cliver. 2000. First findings of *Cryptosporidium* and *Giardia* in California sea lions (*Zalophus californianus*). Journal of Parasitology 86: 490 – 494.

Dierauf, L.A., S.A. Dougherty and L.J. Lowenstine. 1986. Survival versus nonsurvival determinants for neonatal harbour seals. Journal of American Veterinary Medical Association 189: 1024 – 1028.

Dierauf, L.A. and F.M.D. Gulland. 2001. Marine mammal unusual mortality events. pp. 69 – 81. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Dietz, R., M.P. Heide-Jørgensen and T. Härkönen. 1989. Mass deaths of harbour seals (*Phoca vitulina*) in Europe. Ambio 18: 258 – 264.

Dizon, A.E. and W.F. Perrin. 1997. Report of the workshop. pp. 3 – 48. In Molecular genetics of marine mammals. Edited by A.E. Dizon, S.J. Chiv ers and W.F. Perrin. Special Publication No. 3. The Society for Marine Mammalogy. Lawrence, Kansas.

Domning, D.P. 1999. Endangered species. The common denominator. pp. 332 – 366. In Conservation and management of marine mammals. Edited by J.R. Twiss Jr. and R.R. Reeves. Smithsonian Institution Press, Washington.

Duncan, A.E., D.W. Stremme, S. Z. Murray, A.L. Glaser and C.K. Stadler. 2003. Clinical illness in two harbour seals (*Phoca vitulina*) and one grey seal (*Halichoerus grypus*) caused by the West Nile Virus. Proceedings of the American Association of Zoo Veterinarians pp. 202 – 203.

Dunn, J.L., J.D. Buck and T.R. Robeck. 2001. Bacterial diseases of cetaceans and pinnipeds. pp. 309 – 3235. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Early, G.S. and T.P. McKenzie. 1991. The Northeast regional marine mammal stranding network. pp. 63 – 68. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop, Miami, Florida. NOAA Technical Report NMFS 98.

Erwin, P.C., D.A. Bemis, D.I. Mawby, S.B. McCombs, L.L. Sheeler, I.M. Himelright, S.K. Halford, L. Diem, B. Metchock, T.F. Jones, M.G. Schilling and B.V. Thomsen. 2004. *Mycobacterium tuberculosis* transmission from human to canine. Emerging Infectious Diseases 10: 2258 – 2260.

Evans, K., M. Morrice, M. Hindell and D. Thiele. 2002. Three mass strandings of sperm whales (*Physeter macrocephalus*) in southern Australian waters. Marine Mammal Science *18: 622 – 643.*

Ewald, P.W. 1980. Evolutionary biology and the treatment of signs and symptoms of infectious diseases. Journal of Theoretical Biology 86: 169 – 176.

Ewald, P.W. 1983. Host-parasite relations, vectors, and the evolution of disease severity. Annual Review in Ecology and Systematics 14: 465 – 485.

Ewald, P.W. 1994. Evolution of infectious disease. Oxford University Press, Oxford.

Forsyth, M.A., S. Kennedy, S. Wilson, T. Eybatov and T. Barrett. 1998. Canine distemper virus in a Caspian seal. Veterinary Record 143: 662 – 664.

Gage, L.J., J.A. Gerber, D.M. Smith and L.E. Morgan. 1993. Rehabilitation and treatment success rate of California sea lions (Zalophus californianus) and northern fur seals (Callorhinus ursinus) stranded along the Central and Northern California coast, 1984 – 1990. Journal of Zoo and Wildlife Medicine 24: 41 – 47.

Gales, N. and K. Waples. 1993. The rehabilitation and release of bottlenose dolphins from Atlantis Marine Park, Western Australia. Aquatic Mammals 19: 49 – 59.

Gaydos, J.K., K.C. Balcomb, R.W. Osborne, and L. Dierauf. 2004. Evaluating potential infectious disease threats for southern resident killer whales, *Orcinus orca*: a model for endangered species. Biological Conservation 117: 253 – 262.

Geraci, J.R. 1978. The enigma of marine mammal strandings. Oceanus 21: 38 – 47.

Geraci, J.R. and D.J. St. Aubin. 1979. Stranding workshop summary report. pp. 1 – 33. In Biology of marine mammals. Insights through strandings. Edited by J.R. Geraci and D.J. St. Aubin. Report No. MMC-77/13. U.S. Marine Mammal Commission.

Geraci, J.R. and V.J. Lounsbury. 1993. Marine mammals ashore. A field guide for strandings. Texas A&M Sea Grant, Galveston, Texas.

Geraci, J.R., J. Harwood and V.J. Lounsbury. 1999. Marine mammal die-offs. pp. 367 – 395. In Conservation and management of marine mammals. Edited by J.R. Twiss Jr. and R.R. Reeves. Smithsonian Institution Press, Washington.

Goldstein, T., F.M.D. Gulland, B.M. Aldridge, J.T. Harvey, T. Rowles, D.M. Lambourn, S.J. Jeffries, L. Measures, P.K. Yochem, B.S. Stewart, R.J. Small, D.P. King, J.L. Stott and J.A.K. Mazet. 2003. Antibodies to phocine herpesvirus-1 are common in North American harbor seals (*Phoca vitulina*) Journal of Wildlife Diseases 39: 487 – 494.

Griffith, B., J. M. Scott, J.W. Carpenter and C. Reed. 1993. Animal translocations and potential disease transmission. Journal of Zoo and Wildlife Medicine 24: 231 – 236.

Gulland, F.M.D. 1997. The impact of parasites on wild animal populations. Parassitologia 39: 287 – 291.

Gulland, F.M.D., L.J. Lowenstine, J.M. Lapointe, T. Spraker and D.P. King. 1997. Herpesvirus infection in stranded Pacific harbour seals of coastal California. Journal of Wildlife Diseases 33: 450 – 458.

Gulland, F.M.D. 1999. Stranded seals: important sentinels. Journal of American Veterinary Medical Association 214: 1191 – 1192.

Gulland, F.M.D., L.A. Dierauf and T. K. Rowles. 2001. Marine mammal stranding networks. pp. 45 – 67. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Haley, R.W., D.H. Culver, J.W.White, W.M. Morgan and T.G. Emori. 1985. The nationwide nosocomial infection rate: a new need for vital statistics. American Journal of Epidemiology 121: 159 – 167.

Hammill, M.O. and G.B. Stenson. 2000. Estimated prey consumption by harp seals (*Phoca groenlandica*), hooded seals (*Cystophora cristata*), grey seals (*Halichoerus grypus*) and harbour seals (Phoca vitulina) in Atlantic Canada. J. Northw. Atl. Fish. Sci. 26: 1 - 23.

Harder, T.C., H. Vos, R.L. de Swart, and A.D.M.E. Osterhaus. 1997. Age-related disease in recurrent outbreaks of phocid herpesvirus type-1 infections in a seal rehabilitation centre: evaluation of diagnostic methods. The Veterinary Record 140: 500 -503.

Harvell, C.D., K. Kim, J.M. Burkholder, R.R. Colwell, P.R. Epstein, D.J. Grimes, E.E. Hofmann, E.K. Lipp, A.D.M.E. Osterhaus, R.M. Overstreet, J.W. Porter, G.W. Smith and G.R. Vasta. 1999. Emerging marine diseases – climate links and anthropogenic factors. Science 285: 1505-1510.

Harvey, J.T. 1991. Survival and behavior of previously captive harbor seals after release into the wild. pp. 117- 122. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop, Miami, Florida. NOAA Technical Report NMFS 98.

Hastings, B.E., L.J. Lowenstine, L.J. Gage and R.J. Munn. 1989. An epizootic of seal pox in pinnipeds at a rehabilitation center. Journal of Zoo and Wildlife Medicine 20: 282 – 290.

Hill, B.D., I.R. Fraser and H.C. Prior. 1997. Cryptosporidium infection in a dugong (*Dugong dugon*). Australian Veterinary Journal 75: 670 – 671.

Hohn, A.H. and D.M. Wilkinson. 1996. Rehabilitating stranded cetaceans and pinnipeds: management issues and data summary. pp. 30 – 42. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Holshuh, H.J., A.E. Sherrod, C.R. Taylor, B.F. Andrews and E.B. Howard. 1985. Toxoplasmosis in a feral northern fur seal. Journal of American Veterinary Medical Association 187: 1229 – 1230.

Hubálek, Z. 2003. Emerging human infectious diseases: anthroponoses, zoonoses, and sapronoses. Emerging Infectious Diseases 9: 403 – 404.

International Animal Health Code. 2001. Tenth Edition. Office International des Épizooties, Paris, France.

International Aquatic Animal Health Code. 2004. Seventh Edition. Office International des Épizooties, Paris, France.

International Council for the Exploration of the Sea (ICES). 1993. Report of the ICES workshop on the distribution and sources of pathogens in marine mammals. CM.1993/N:6

International Council for the Exploration of the Sea (ICES). 2003. Code of practice on the introductions and transfers of marine organisms.

International Terrestrial Animal Health Code. 2004. Thirteenth Edition. Office International des Épizooties, Paris, France.

International Union for the Conservation of Nature (IUCN). 1987. IUCN Position statement on translocation of living organisms. 22nd meeting of the IUCN Council, Gland, Switzerland.

International Union for the Conservation of Nature (IUCN). 1995. IUCN/SSC Guidelines for re-introductions. 41st meeting of the IUCN Council, Gland, Switzerland.

Jensen, T., M. van de Bildt, H.H. Dietz, T.H. Andersen, A.S. Hammer, T. Kuiken and A. Osterhaus.. 2002. Another phocine distemper outbreak in Europe. Science 297: 209.

Johnson, S.P., S. Noland and F.M.D. Gulland. 1998. Antimicrobial susceptibility of bacteria isolated from pinnipeds stranded in Central and Northern California. Journal of Zoo and Wildlife Medicine 29: 288 – 294.

Kellert, S.R. 1991. Canadian perceptions of marine mammal conservation and management in the Northwest Atlantic. International Marine Mammal Association Inc. Technical Report No. 91 – 04.

Kennedy, S., T. Kuiken, P.D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M.W.G. van de Bildt, A.D.M.E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, S. Wilson. 2000. Mass die-off of Caspian seals caused by canine distemper virus. Emerging Infectious Diseases 6: 637 – 639.

King, D.P., A.R. Lie, T. Goldstein, B.M. Aldridge, F.M.D. Gulland, M. Haulena, M.A. Adkison, L.J. Lowenstine and J.L. Stott. 2001. Humoral immune responses to phocine herpesvirus-1 in Pacific harbor seals (*Phoca vitulina richardsii*) during an outbreak of clinical disease. Veterinary Microbiology 80: 1 – 8.

Kruse, H., A-M. Kirkemo and K. Handeland. 2004. Wildlife as source of zoonotic infections. Emerging Infectious Diseases 10: 2067 – 2072.

Lafferty, K.D. and L.R. Gerber. 2002. Good medicine for conservation biology: the intersection of epidemiology and conservation theory. Conservation Biology 16: 593 – 604.

Lander, M. E., F.M.D. Gulland and R.L. Delong. 2000. Satellite tracking a rehabilitated Guadalupe fur seal (*Arctocephalus townsendi*). Aquatic Mammals 26: 137 – 142.

Lander, M.E., J.T. Harvey, K.D. Hanni, and L.E. Morgan. 2002. Behavior, movements, and apparent survival of rehabilitated and free-ranging harbour seal pups. Journal of Wildlife Management 66: 19 – 28.

Larson, G. 1999. There's a hair in my dirt. A worm's story. HarperCollins Publishers Inc., New York.

Lavigne, D.M., V.B. Scheffer and S.R. Kellert. 1999. The evolution of North American attitudes toward marine mammals. pp.10 – 86. In Conservation and management of marine mammals. Edited by J.R. Twiss Jr. and R.R. Reeves. Smithsonian Institution Press, Washington.

Le Boeuf, B.J. 1996. Behavioral issues in returning marine mammals to their habitat. pp. 49 – 54. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Lucas, Z., P-Y Daoust, G. Conboy and M. Brimacombe. 2003. Health status of harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora cristata*) on Sable Island, Nova Scotia, Canada, concurrent with their expanding range. Journal of Wildlife Diseases 39: 16 – 28.

Malakoff, D. 2001. Scientists use strandings to bring species to life. Science 293: 1754 - 1757.

Mamaev, L.V., N.N. Denikina, S. I. Belikov, V.E. Volichikov, I.K.G. Visser and M. Fleming. 1995. Characteristics of morbilliviruses isolated from Lake Baikal seals (*Phoca sibirica*). Veterinary Microbiology 40: 251 – 259.

Manire, C.A., H.L. Rhinehart, N.B. Barros, L. Byrd and P. Cunningham-Smith. 2004. An approach to the rehabilitation of *Kogia*. spp. Aquatic Mammals 30: 257 – 270.

Manual of Diagnostic Tests for Aquatic Animals. 2003. Fourth Edition. Office International des Epizooties, Paris, France.

Martina, B.E.E., T.H. Jensen, M.W.G. van de Bildt, T.C. Harder and A.D.M.E. Osterhaus. 2002. Variations in the severity of phocid herpesvirus type 1 infections with age in grey seals and harbour seals. The Veterinary Record 150: 572 – 575.

Mate, B.R., K.M. Stafford, R. Nawojchik and J.L. Dunn. 1994. Movements and dive behavior of a satellite-monitored Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in the Gulf of Maine. Marine Mammal Science 10: 116 – 121.

McAlpine, D.F., P.T. Stevick and L.D. Murison. 1999. Increase in extralimital occurrences of ice-breeding seals in the northern Gulf of Maine region: more seals or fewer fish? Marine Mammal Science 15: 906 – 911.

McCallum, H. and A. Dobson. 1995. Detecting disease and parasite threats to endangered species and ecosystems. Trends in Ecology and Evolution 10: 190 – 194.

Measures, L.N. and M. Olson. 1999. Giardiasis in pinnipeds from eastern Canada. Journal of Wildlife Diseases 35: 779 – 782.

Measures, L.N., J.P. Dubey, P. Labelle, and D. Martineau. 2004. Seroprevalence of *Toxoplasma gondii* in Canadian pinnipeds. Journal of Wildlife Diseases 40: 294 – 300.

Migaki, G., J.F. Allen and H.W. Casey. 1977. Toxoplasmosis in a California sea lion (*Zalophus californianus*). American Journal of Veterinary Research 38: 135 – 136.

Miller, R. E. 1996. Disease and reintroductions-an overview. pp. 43 – 45. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Miller, D.L., R. Y. Ewing and G.G. Bossart. 2001. Emerging and resurging diseases. pp. 15 – 30. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Miller, M.A., I.A. Gardner, C. Kreuder, D.M. Paradies, K.R. Worcester, D.A. Jessup, E. Dodd, M.D. Harris, J.A. Ames, A.E. Packham, and P.A. Conrad. 2002. Coastal freshwater runoff is a risk factor for *Toxoplasma gondii* infection of southern sea otters (*Enhydra lutris nereis*). International Journal of Parasitology 32: 997 – 1006.

Miller, M.A., M.E. Grigg, C. Kreuder, E.R. James, A.C. Melli, P.R. Crosbie, D.A. Jessup, J.C. Boothroyd, D. Brownstein and P.A. Conrad.. 2004. An unusual genotype of *Toxoplasma gondii* is common in California sea otters (*Enhydra lutris nereis*) and is a cause of mortality. International Journal for Parasitology 34: 275 – 284.

Minette, H.P. 1986. Salmonellosis in the marine environment. A review and commentary. International Journal of Zoonoses 13: 71 – 75.

Montali, R.J. and M. Bush. 1996. Models for disease containment in captive terrestrial mammals destined for reintroduction. pp. 46 – 48. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Mos, L., P.S. Ross, D. McIntosh and S. Raverty. 2003. Canine distemper virus in river otters in British Columbia as an emergent risk for coastal pinnipeds. The Veterinary Record 152: 237 – 239.

National Oceanic and Atmospheric Administration (NOAA). 1997. Draft release of stranded marine mammals to the wild: background, preparation, and release criteria. NOAA Technical Memorandum. U.S. Department of Commerce.

Nawojchik, R., D.J. St. Aubin and A. Johnson. 2003. Movements and dive behaviour of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the northwest Atlantic. Marine Mammal Science 19: 232 – 239.

Nitta, E.T. 1991. The marine mammal stranding network for Hawaii, an overview. pp. 55 – 62. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop. Miami, Florida. NOAA Technical Report NMFS 98.

Nunoya, T., M. Tajima, Y. Ishikawa, T. Samejima, H. Ishikawa and K. Hasegawa. 1990. Occurrence of a canine distemper-like disease in aquarium seals. Japanese Journal of Veterinary Science 52: 469 – 477.

O'Brien, S.J. and J.F. Evermann. 1988. Interactive influence of infectious disease and genetic diversity in natural populations. Trends in Ecology and Evolution 3: 254 – 259.

Odell, D.K. 1991. A review of the Southeastern United States marine mammal stranding network: 1978 – 1987. pp. 19 – 23. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop. Miami, Florida. NOAA Technical Report NMFS 98.

Odell, D.K., E. Asper, J. Baucom, and L. Cornell. 1980. A recurrent mass stranding of false killer whales, *Pseudorca crassidens*, in Florida. Fishery Bulletin 78: 171 – 177.

Ohishi, K., A. Ninomiya, H. Kida, C-H Park, T. Maruyama, T. Arai, E. Katsumata, T. Tobayama, A.N. Boltunov, L.S. Khuraskin and N. Miyazaki. 2002. Serological evidence of transmission of human influenza A and B viruses to Caspian seals *(Phoca caspica)*. Microbiology and Immunology 46: 639 – 644.

Ohishi, K., N. Kishida, A. Ninomiya, H. Kida, Y. Takada, N. Miyazaki, A.N. Boltunov and T. Maruyama. 2004. Antibodies to human-related H3 influenza A virus in Baikal seals (*Phoca sibirica*) and ringed seals (*Phoca hispida*) in Russia. Microbiology and Immunology 48: 905 – 910.

Olson, M.E., P.D. Roach, M. Stabler and W. Chan. 1997. Giardiasis in ringed seals from the western arctic. Journal of Wildlife Diseases 33: 646 – 648.

Osterhaus, A. D.M.E. 2001. Catastrophes after crossing species barriers. Philosophical Transactions of the Royal Society of London B 356: 791 – 793.

Osterhaus, A.D.M.E., G.F. Rimmelzwaan, B.E.E. Martina, T.M. Bestebroer and R.A.M. Fouchier. 2000. Influenza B virus in seals. Science 288: 1051 – 1053.

Perrin, W.F. and J.R. Geraci. 2002. Stranding. pp. 1192 – 1197. In Encyclopedia of marine mammals. Edited by W.F. Perrin, B. Würsig and J.G.M. Thewissen. Academic Press, San Diego.

Pfeiffer, C.J. (Editor). 2002. Molecular and cell biology of marine mammals. Krieger Publishing Company, Malabar, Florida.

Ratcliffe, H.L. and C.B. Worth. 1951. Toxoplasmosis of captive wild birds and mammals. American Journal of Pathology 27: 655 – 667.

Rebar, A.H., T.P. Lipscomb, R.K. Harris and B.E. Ballachey. 1995. Clinical and clinical laboratory correlates in sea otters dying unexpectedly in rehabilitation centers following the Exxon Valdez oil spill. Veterinary Pathology 32: 346 – 50.

Reddy, M.L., L.A. Dierauf and F.M.D. Gulland. 2001. Marine mammals as sentinels of ocean health. pp. 3 – 13. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Reeves, R.R. and P.J.H. Reijnders. 2002. Conservation and management of marine mammals. pp. 388 – 416. In Marine Mammal biology: an evolutionary approach. Edited by A.R. Hoelzel. Blackwell Publications, Oxford.

Reijnders, P.J., S.M.J.M. Brasseur and E.H. Ries. 1996. The release of seals from captive breeding and rehabilitation programs: a useful conservation management tool? pp. 54 – 65. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Reynolds, J.E. III and D.K. Odell (Editors). 1991. Marine mammal strandings in the United States. Proceedings of the second marine mammal stranding workshop, Miami, Florida. NOAA Technical Report NMFS 98.

Ridgway, S.H. and J.H. Prescott. 1979. The quandry of whether to retain or release rehabilitated strandlings. pp. 298 – 299. In Biology of marine mammals. Insights through strandings. Edited by J.R. Geraci and D.J. St. Aubin. Report No. MMC-77/13. U.S. Marine Mammal Commission.

Riley, S.P.D., J. Foley and B. Chomel. 2004. Exposure to feline and canine pathogens in bobcats and gray foxes in urban and rural zones of a national park in California. Journal of Wildlife Diseases 40: 11 – 22.

Ross, P.S. 2002. The role of immunotoxic environmental contaminants in facilitating the emergence of infectious diseases in marine mammals. Human and Ecological Risk Assessment 8: 277 - 292.

Scordino, J. 1991. Overview of the Northwest region marine mammal stranding network, 1977 – 1987. pp. 35 – 42. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop, Miami, Florida. NOAA Technical Report NMFS 98.

Scott, M.E. 1988. The impact of infection and disease on animal populations: implications for conservation biology. Conservation Biology 2: 40 – 56.

Scott, M.D., A.A. Hohn, A.J. Westgate, J.R. Nicholas, B.R. Whitaker and W.B. Campbell. 2001. A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*). Journal of Cetacean Research Management 3: 87 – 94.

Seagars, D.J. 1988. The fate of released rehabilitated pinnipeds based on tag-resight information: a preliminary assessment. National Marine Fisheries Service, Southwest Region. Administrative Report SWR-88-1.

Seagars, D.J. and E.A.Jozwiak. 1991. The California marine mammal stranding network, 1972 – 1987: implementation, status, recent events, and goals. pp. 25 – 33. In Marine mammal strandings in the United States. J.E. Reynolds III and D.K. Odell (Editors). Proceedings of the second marine mammal stranding workshop, Miami, Florida. NOAA Technical Report NMFS 98.

Seagars, D.J., J.H. Lecky, J.J. Slawson and H. S. Stone. 1986. Evaluation of the California marine mammal stranding network as a management tool based on records for 1983 and 1984. National Marine Fisheries Service, Southwest Region. Administrative Report SWR-86-5.

Société des parcs de sciences naturelles du Québec (SPSNQ). 2005. Zone de protection marine de l'estuaire du Saint-Laurent et mesure d'interdiction de la réhabilitation de mammifères marins visant leur réintroduction dans le milieu naturel ou tout autre introduction non naturelle. Proposition de Pêches et Océans Canada. Mémoire du Parc Aquarium du Québec, SPSNQ.

Spalding, M. and D.J. Forrester. 1993. Disease monitoring of free-ranging and released wildlife. Journal of Zoo and Wildlife Medicine 24: 271 – 280.

Stamper, M.A., F.M.D. Gulland and T. Spraker. 1998. Leptospirosis in rehabilitated Pacific harbour seals from California. Journal of Wildlife Diseases 34: 407 – 410.

St. Aubin, D.J., J.R. Geraci and V.J. Lounsbury. 1996. Workshop summary and recommendations. pp. 1 – 24. In Rescue, rehabilitation and release of marine mammals: an analysis of current views and practices. Edited by D.J. St. Aubin, J.R. Geraci and V.J. Lounsbury. NOAA Technical Memorandum NMFS-OPR-8.

Stewart, B.S. , J. Harvey and P.K. Yochem. 2001. Post-release monitoring and tracking of a rehabilitated California gray whale. Aquatic Mammals 27: 294 – 300.

Su, C., D. Evans, R.H. Cole, J.C. Kissinger, J.W. Ajioka and L.D. Sibley. 2003. Recent expansion of *Toxoplasma* through enhanced oral transmission. Science 299: 414 – 416.

Thornton, S.M., S. Nolan and F.M.D. Gulland. 1998. Bacterial isolates from California sea lion (*Zalophus californianus*), harbour seals (*Phoca vitulina*), and northern elephant seals (*Mirounga angustirostris*) admitted to a rehabilitation center along the central California coast, 1994 – 1995. Journal of Zoo and Wildlife Medicine 29: 171 – 176.

Tuomi, P. 2001. Sea otters. pp. 961 – 987. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Valsecchi, E., W. Amos, J.A. Raga, M. Podesta and W. Sherwin. 2004. The effects of inbreeding on mortality during a morbillivirus outbreak in the Mediterranean striped dolphin (*Stenella coeruleoalba*). Animal Conservation 7: 139 – 146.

van Duijken, E., M.J.H.M. Wolfhagen, A.T.A. Box, M.E.O.C. Heck, W.J.B. Wannet and A.C. Fluit. 2004. Human-to-dog transmission of methicillin-resistant *Staphylococcus aureus*. Emerging Infectious Diseases 10: 2235 – 2237.

Van Pelt, R.W., and R.A. Dieterich. 1973. Staphylococcal infection and toxoplasmosis in a young harbour seal. Journal of Wildlife Diseases 9: 258 – 261.

Vincent, C., V. Ridoux, M.A. Fedak and S. Hassani. 2002. Mark-recapture and satellite tracking of rehabilitated juvenile grey seals (*Halichoerus grypus*): dispersal and potential effects on wild populations. Aquatic Mammals 28: 121 – 130.

Walsh, M.T., R.Y. Ewing, D.K. Odell and G.D. Bossart. 2001. Mass strandings of cetaceans. pp. 83 – 96. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Webster, R.G., J. Geraci, G. Petursson and K. Skirnisson. 1981. Conjunctivitis in human beings caused by influenza A virus of seals. New England Journal of Medicine 304: 911.

Wells, R.S., K. Bassos-Hull and K.S. Norris. 1998. Experimental return to the wild of two bottlenose dolphins. Marine Mammal Science 14: 51 – 71.

Wells, R.S., H.L. Rhinehart, P. Cunningham, J. Whaley, M. Baran, C. Koberna and D.P. Costa. 1999. Long distance offshore movements of bottlenose dolphins. Marine Mammal Science 15: 1098 – 1114.

Wiley, D.N., G. Early, C.A. Mayo and M.J. Moore. 2001. Rescue and release of mass stranded cetaceans from beaches on Cape Cod, Massachusetts, USA: 1990 – 1999: a review of some response actions. Aquatic Mammals 27: 162 - 171.

Wilkinson, D.M. 1996. National contingency plan for response to unusual marine mammal mortality events. NOAA Technical Memorandum NMFS-OPR-9.

Wilkinson, D. and G.A.J. Worthy. 1999. Marine mammal stranding networks. pp. 396 – 411. In Conservation and management of marine mammals. Edited by J.R. Twiss Jr. and R.R. Reeves. Smithsonian Institution Press, Washington.

Wise, R. and E.J.L. Soulsby. 2002. Antibiotic resistance – an evolving problem. Veterinary Record 151: 371 – 372.

Woodford, M.H. and P.B. Rossiter. 1993. Disease risks associated with wildlife translocation projects. Revue scientifique et technique de l'Office international des Épizooties 12: 115 – 135.

Young, N.M. and S.L. Shapiro. 2001. U.S. Federal legislation governing marine mammals. pp. 741 – 766. In CRC Handbook of marine mammal medicine. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton.

Table 1. Status of sympatric marine mammals at risk in Canadian and American waters.

Species of marine mammal	SARA/COSEWIC status in Canada	ESA Status in USA	CITES Appendix	CMS Appendix
bowhead whale	E	E	I	I
North Atlantic right whale	E	E	I	I
North Pacific right whale	E	E		I
sei whale	E(NE Pacific)	E	I	I & II
blue whale	E	E	I	I
fin whale	SC	E	I	I & II
humpback whale	T(NE Pacific)	E	I	I
gray whale	SC(NE Pacific)	-	I	
sperm whale		E	I	I & II
northern bottlenose whale	E(NW Atlantic)	-	I	II
killer whale:				
NE Pacific southern resident	E	D	I	II
NE Pacific northern resident	T	-	I	II
NE Pacific transient	T	-	I	II
NE Pacific offshore	SC	-	I	II
St. Lawrence beluga	T	-	I	
arctic beluga (some populations)	E, T, SC	D(Cook Inlet)	I	II
Sowerby's beaked whale	SC (NW Atlantic)		II	
harbour porpoise (Northwest Atlantic population)	T	-	II	II
Steller sea lion-western population	-	E		
Steller sea lion-southeastern population	SC	T		
sea otter	T	T	I	

Table 1. Status of sympatric marine mammals at risk in Canadian and American waters (cont'd).

E-endangered, T-threatened, SC-special concern, D-depleted under U.S. MMPA.
SARA/COSEWIC-Species at Risk Act/Committee on the Status of Endangered Wildlife in Canada
CITES-Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS-Convention on Migratory Species
Note: Narwhal is listed by CMS (Appendix II) but not at risk in Canada or the U.S.

Table 2. Countries that monitor stranding events and engage in rehabilitation activities.

Country	Strandings monitored*	Rehabilitation	Comments on rehabilitation efforts
Argentina	yes, limited	yes	
Australia	yes	yes	Scientifc Committee on Antarctic Research discourages release of seals post-capture.
Belgium	yes	yes	cetaceans (mostly harbour porpoise) to aquarium in Holland, seals to rehab center in Belgium
Brazil	yes	yes	manatees only
Canada	yes-limited. Quebec, Central & Arctic, & Pacific Regions	yes, B.C. only	Moratorium on rehabilitation in Quebec Region.
Denmark	yes	no	
France	yes	yes	cetaceans-rescue or euthanasia. Seals to rehab centers.
Germany	yes	yes	cetaceans (mostly harbour porpoise) to aquarium in Holland, seals to rehab center in Germany.
Greece	yes, limited	no	
Hong Kong	yes	yes	
Israel	yes	yes	
Italy	yes	yes	

Table 2. Countries that monitor stranding events and engage in rehabilitation activities (cont'd).

Country	Strandings monitored*	Rehabilitation	Comments on rehabilitation efforts.
Japan	yes	yes, limited	some small cetaceans to local aquaria.
Maldives	yes	no	
Malta	yes	yes	
Mexico	yes	no	
Holland	yes	yes	cetaceans (mostly harbour porpoise) to aquarium or seal rehab center in Holland.
New Zealand	yes	no	refloating of cetaceans only or euthanasia.
Spain	yes	yes	turtles and cetaceans only
Sweden	yes (seals only)	no	
Ukraine	yes	no	
United Kingdom	yes	yes	rehab of seals only. Young cetaceans often euthanized.
United States	yes	yes	rehab of all marine mammals attempted, euthanasia permitted.

*local or national database.
Source of information: Wilkinson 1996; Gulland et al. 2001

Table 3. Transmission of diseases to marine mammals from humans, their domestic animals or within rehabilitation centers, aquaria or zoological parks

Disease/Etiological agent	Marine mammal host	Source	Reference
phocine herpesvirus-1	NE Atlantic harbour seal, NE Atlantic grey seals, Pacific harbour seal	harbour and grey seals in rehab center	Harder et al. 1997; Gulland et al. 1997; King et al. 2001; Martina et al. 2002; Goldstein et al. 2003
sealpox	Pacific harbour seal, California sea lion, northern elephant seals	Pacific harbour seals in rehab center	Hastings et al. 1989
herpes-like virus?	sea otter	hypothesis: latent infections re-activated during stress of rehabilitation during Exxon Valdez oil spill, possible transmission within center.	Rebar et al. 1995; but see Tuomi 2001
West Nile Virus	harbour and grey seals	mosquitos in a zoological park setting	Duncan et al. 2003
canine distemper virus	Baikal, Caspian and crabeater seals	wild Baikal seals in aquarium, dogs, wild canids	Nunoya et al. 1990; Bengston et al. 1991; Mamaev et al. 1995; Kennedy et al. 2000
Influenza A and B	Caspian, Baikal and ringed seals	humans	Ohishi et al. 2002, 2004
Influenza B	NE Atlantic harbour seals	humans (in rehab center?)	Osterhaus et al. 2000
Mycoplasma spp.	grey and harbour seals, California sea lion, northern elephant seal	other captive seals (aquaria, rehab. center?)	Measures (unpublished data)
Mycobacteria tuberculosis complex	Australian sea lion, New Zealand fur seal, various wild otariids	sea lions in marine park, human sewage, domestic animal wastes?	Cousins et al 1993; but see Dunn et al. 2001
Leptospira interrogans	Pacific harbour seals	California sea lions, northern elephant seals in rehab center or local wildlife	Stamper et al. 1998

Table 3. Transmission of diseases to marine mammals from humans, their domestic animals or within rehabilitation centers, aquaria or zoological parks (cont'd).

Disease/Etiological agent	Marine mammal host	Source	Reference
Salmonella spp.	harp and harbour seals	human sewage or domestic animal waste?	Baker et al. 1995; Minette 1986; Aschfalk et al. 2002
Toxoplasma gondii	California sea lion, Pacific and Atlantic harbour seal, northern fur seal, hooded seal, grey seal	domestic cats (via oocyst-contaminated food and water)	Ratcliffe and Worth 1951; Migaki et al. 1977; Van Pelt and Dieterich 1973; Holshuh et al. 1985; Miller et al. 2002; Measures et al. 2004
Giardia duodenalis	ringed, harp, harbour, and grey seals, California sea lions	human sewage or domestic animal waste	Olson et al. 1997; Measures and Olson 1999; Deng et al 2000
Cryptosporidium parvum	dugong, California sea lions	human sewage or domestic animal waste	Deng et al. 2000; Hill et al. 1997

Appendix 1. Recommended proposed regulations pertaining to rehabilitation of marine mammals in Canada.

Rehabilitation centers (RC)

- RC should be located near the natural habitat of marine mammals (coastal marine areas), preferably not far inland where terrestrial wildlife may exist nor in agricultural or municipal areas where domestic animals or municipal and agricultural sewage or waste may pose risks.
- RC should have adequate, certifiable biocontainment standards to exclude mice, rats, squirrels, raccoons, cats, birds and insects such as ticks, mosquitos and roaches that may act as intermediate hosts, vectors or phoretic agents. Containment standards for veterinary facilities (AAFC 1996) and CCAC guidelines on laboratory animal facilities – characteristics, design and development (CCAC 2003b) are useful guides as are other CCAC, OIE and IUCN guidelines (see Literature Cited). Standard operational procedures (SOP) and good clinical practices (GCP) should be developed.
- No marine mammal RC should also rehabilitate terrestrial wildlife in the same facility nor permit wildlife or domestic animal entry.
- Personnel working in a RC should have annual medical examinations including vaccination against certain communicable diseases such as measles, rabies, etc. Personnel with infectious diseases such as influenza or tuberculosis, immunocompromised, on antibiotic treatment or pregnant should not be permitted to work in a RC.
- RC should be inspected annually to ensure that standards and requirements are met.
- RC should have a CCAC animal care committee and adhere to CCAC guidelines.
- Rescued animals should be quarantined from other animals in the RC until clinical examination determines that risk of spread of communicable diseases is low.
- RC should be fully equipped with a clinical examination room, necropsy room, quarantine area, adequate salt-water facilities to hold a pre-determined number of marine mammals undergoing rehabilitation and freezer capacity for storing large quantities of food fed to marine mammals. Frozen food should be used within one year or discarded and replaced annually.
- Marine mammals should be given a nutritionally balanced supply of high quality food and vitamins free of chemical and microbial contaminants. Food (marine fish and invertebrates) should be stored adequately and examined at point of purchase for quality, freshness, safety and energetic value. This food should come from the same geographic region where rescued marine mammals live and this food should be part of their normal diet. Artificial diets (particularly for unweaned animals) should be carefully developed or chosen to eliminate nutritional, digestive or allergic problems – use of previously validated and safe artificial diets for marine mammals are preferred.
- All rescued marine mammals should have a thorough veterinary clinical examination on entry to the RC. Any animal determined to have a negative prognosis for recovery or return to the wild such as serious injury or illness should be euthanized.

Appendix 1. Recommended proposed regulations pertaining to rehabilitation of marine mammals in Canada (cont'd).

Rehabilitation and Release criteria

- Handling of animals should be minimized during rehabilitation.
- All marine mammals should be released within four to six months of capture.
- During rehabilitation animals should be clinically monitored regularly for response to therapy and signs of recovery.
- All animals ready for release require complete veterinary clinical examination including analysis of rescue and capture history, veterinary clinical history, haematology, cytology, biochemistry, serology, immune and endocrine competency, parasitic and microbial flora, and be free of antibiotics or other drug residues. Analysis of behaviour including demonstration of lack of habituation to humans or other behaviours that may promote interactions with humans, enhance susceptibility to predation or spread disease. Only healthy weaned animals (in reasonable body condition at age) able to forage independently as soon as they are able to meet these requirements should be released under DFO permit after risk assessment is complete, details of which to be specified by the DFO..
- Euthanized animals and animals dying in the RC should have a thorough necropsy by a certified veterinary pathologist.
- Released animals should be tagged and monitored for dispersal, mortality, reproduction, post-release health monitoring and determination of the outcome of rehabilitation efforts.
- Any animal with documented carrier status for any highly infectious disease of threat to wild marine mammal species or populations or predators cannot be released (euthanasia would be recommended). Direct and indirect detection for evidence of infection including use of molecular biological techniques validated for marine mammals should be employed.
- Subclinical parasitism should not be treated and normal bacterial flora should be restored prior to release.
- No animal should be rehabilitated outside its geographic region and release should be near its point of capture at a safe location away from human habitation or frequentation and within its natural range. An animal wandering into an exotic location outside its normal range should not be rehabilitated and re-located to its normal range.
- Records on all animals, veterinary procedures, treatments and laboratory results must be maintained and available for inspection. Disease prevalence, results of rehabilitation efforts, necropsy results, etc. should be published in peer-reviewed journals on a regular basis.
- Information on the biodiversity of parasites, microbial fauna, disease vectors and reservoir hosts in free-ranging "healthy" marine mammals within the geographic region where animals are rescued and released (i.e. baseline data) should be obtained regularly in order to monitor the health of wild populations, to detect new emerging diseases and to determine whether a rehabilitated animal should be released as part of an environmental impact assessment as well as to detect whether diseases are being spread by rehabilitation activities.